APPARATUS FOR THE AXIAL MOVEMENT OF PIPING OR THE LIKE

DESCRIPTION

The present invention refers to an apparatus for the axial movement of piping or the like, particularly useful during steps of salvaging from wells or tanks, or during the reverse step of laying in-depth, of piping and/or motor pumps.

Hereinafter, for simplicity's sake reference will likewise be made to two specific applications of the present invention, in particular to the hoisting and to the laying, in a vertical direction with respect to the ground, of piping. More specifically, it will be made reference to the field of submersible pumps used to extract water, etc., from wells and/or tanks.

Of course, it is understood that the present invention could apply to all those cases in which it is necessary to move piping elements or the like according to an axial direction thereof, anyhow tilted (or not tilted) with respect to the ground.

As it is known, such submersible pumps are lowered in-depth into the well and connected to the surface by piping for water extraction.

Depending on the capacity and depth, the assembly of the pump and of the piping connected thereto may reach markedly elevated weight values, thereby making in the first instance a laying and then a subsequent salvage of the pump itself difficult.

In the state of the art, the laying in-depth and the salvaging of submersible motor pumps are generally carried out by means of a system manually operated by one or more operators.

As a rule, a (nylon or steel) cable or rope is present, having one end thereof connected to the body of the pump and through which the latter is lowered and then salvaged. The cable is reeled out and then reeled in by means of a manually (foot-) operated (pedal) winch.

Alternatively, for reeling out or salvaging the cable, at pump laying or salvaging, respectively, a mechanical arm is used, placed e.g. on a heavy motor vehicle.

However, suchlike techniques entail remarkable limitations and drawbacks.

A first drawback concerns their limited applicability, owing to the maximum weight bearable by the cable.

Moreover, known-art systems require the attendance and the intervention of several persons, and, especially in the case of heavy pumps and piping, subject the individual operator to an excessive physical effort.

A further drawback is that these known techniques can also prove hazardous to operators, since, e.g. due to overhung items and/or weights, not all maneuvers may be performed in total safety.

Hence, object of the present invention is to solve said problems, by providing an

apparatus as defined in claim 1.

The advantages, the features and the operation modes of the present invention will be made apparent in the following detailed description of a preferred embodiment thereof, given by way of example and not for limitative purposes, with reference to the figures of the annexed drawings, wherein:

- Figure 1 is a general view of a first embodiment of the apparatus according to the present invention;
- Figure 2 is a view of a detail of Figure 1;
- Figure 3 illustrates a variant embodiment of the actuation means of the moving assembly of the apparatus according to the present invention, with a hydraulic drive system;
- Figures 4A and 4B are perspective views of hoisting elements mounted on the apparatus according to the embodiment of Figure 1;
- Figure 5 is a top sectional view of the hoisting element of Figure 4A;
- Figure 6 is a side sectional view of a hoisting element for the apparatus according to the embodiment of Figure 1;
- Figures 7A, 7B, 7C are schematic views apt to illustrate the operation principle of the apparatus according to the embodiment of Figure 1;
- Figures 8A, 8B, 8C, 8D are perspective views of the apparatus according to the embodiment of Figure 1, illustrating its use with a piping hoisting operation mode;
- Figures 9A, 9B, 9C are views of a hoisting element of the apparatus according to the embodiment of Figure 1, having a pipe release device;
- Figure 10 is a side sectional view illustrating a constructive variant for the hoisting elements of Figures 4A and 4B.
- Figure 11 is a general view of a second embodiment of the apparatus according to the present invention, with a lowering operation mode for the laying in-depth of piping;
- Figure 12 is a view of a detail of Figure 11;
- Figures 13 and 14 are perspective views of hoisting elements of the apparatus according to the embodiment of Figure 11;
- Figure 15 is a top sectional view of the hosting element of Figure 13;
- Figures 16A, 16B, 16C, 16D are side views of the moving assembly of the apparatus according to the embodiment of Figure 11, illustrating the operation modes thereof for laying piping;
- Figure 17 illustrates a variant embodiment of the actuation means of the moving assembly of the apparatus according to the present invention, with a

drive system having a worm screw-nut screw coupling;

- Figure 18 illustrates a photoelectric detection control system of the actuation means of the moving assembly of the apparatus according to the present invention;
- Figure 19 is a perspective view of a constructive variant of a hoisting element of the apparatus according to the embodiment of Figure 11;
- Figure 20 is a top sectional view of the hoisting element of Figure 19;
- Figure 21 is a perspective view of a constructive variant of the tightening means of a hoisting element of the apparatus according to the embodiment of Figure 11; and
- Figure 22 is a side view illustrating the structure and the operation of the tightening means of Figure 21.

To describe the present invention, hereinafter it will be made reference to the above figures.

Figure 1 generally shows a first embodiment of the apparatus 1 according to the present invention, specifically adapted to carry out piping salvage steps.

A piping or pipe 2, previously lowered in a hole 3 (e.g., a well) on the ground 4, needs extracting to be salvaged upon completion of the job.

The apparatus 1 comprises a frame 5, firmly resting on the ground 4 by means of feet 6.

To the frame 5, first of all there is rigidly connected a moving assembly 10, more evident in the next Figure 2.

The moving assembly 10 in turn comprises a top hoisting element 11, rigidly fixed onto the frame 5.

Four guides 12, e.g., made with rack sections, branch off at the top hoisting element 11.

On said guides there may slide a movable hoisting element 13, e.g., mounted on gears or wheels 14.

The two hoisting elements 11 and 13 are mounted in a manner such as to be perfectly aligned therebetween.

The movable hoisting element 13 is driven by means of an electric motor 15 acting on a connecting rod system 16, in a manner such as to describe a reciprocating motion between a bottom dead center BDC and a top dead center TDC.

Alternatively to the electric motor and the connecting rod system, there could be used a hydraulic drive system using, e.g., a pair of rams 17, as it is evident in Figure 3.

The top 11 and movable 13 hoisting elements have, apart from the presence of the

gears 14, the same structure that will be illustrated with regard to the next figures.

In particular, as it is evident in Figure 4B, they are made in the form of a boxed body, comprising a passage hole 20 for the piping 2 to be moved.

Internally to said hole 20, the hoisting elements have a wall portion 21, preferably of a rounded or semi-cylindrical shape, onto which there may rest a corresponding portion of the pipe 2. Preferably, such a wall 21 has a surface exhibiting a high friction coefficient or machined in a manner such as to have knurls or toothings apt to mesh to the external wall of the pipe 2.

Of course, the selection of the materials is left to those skilled in the art. Evidently, for the use in conjunction with metal piping it will be preferable to make the toothed and/or knurled surface from steel, whereas for plastic piping or the like it will be preferable to make said surfaces from rubber materials exhibiting a high friction coefficient.

In addition, the hoisting element further comprises a tightening device substantially made of a roll element 22 having a globe-shaped contour. The surface of the roll 22 is it also preferably made from material exhibiting a high friction coefficient or machined so as to have knurls or toothings apt to mesh to the external wall of the pipe 2.

The roll 22 is integral to a shaft 23 that is mounted on a pair of gears 24.

The gears 24 are coupled to two linear racks 25, and movable therealong.

The racks 25 are integral to the boxed body and tilted with respect to a horizontal working plane and to the pipe 2 to be moved, as it is evident in Figure 6.

The shaft 23 can slide inside a pair of guide slots 26 obtained on the lateral sides of the body of the hoisting element.

The slots 26 are parallel to the sliding racks 25.

A pair of elastic elements 30, e.g. a pair of helical springs, connects the two ends of the shaft 23 to two corresponding points 31 integral to the main body of the hoisting element.

In the absence of external stresses, the action of the elastic elements 30 is that of returning the roll 22 toward the piping 2, by rolling the gears onto the racks.

The operation of the individual hoisting element depends on its relative motion with respect to the piping 2 inserted therein.

In particular, referring to Figure 6, when the relative motion is that indicated by the arrows F1 and F2, the roll 22, which anyhow contacts the piping 2, tends to rotate in the sense indicated by the arrow F3 and then to move along the rack in the direction of the pipe 2 itself. In this manner, the pipe is held constrained between the wall 21 of the hoisting element and the surface of the roll 22, making a self-

tightening mechanism.

On the other hand, when the relative motion is that indicated by the arrows F4 and F5, the roll 22 tends to rotate in the sense indicated by the arrow F6 and then to move along the rack in an opposite direction with respect to the pipe 2 itself.

In this manner, the roll 22 'frees' the pipe, which may then slide through the hoisting element without hindrances due to friction or to specific tightening steps.

On the basis of this operation principle, the operation modes of said first embodiment of the apparatus 1 according to the present invention, with reference to the salvage procedures of a piping 2, will be illustrated in the next Figures 7A, 7B and 7C.

Said figures schematically depict the top hoisting element 11, integral to the support frame 5 of the apparatus, and the movable hoisting element 13.

The TDC and BDC positions between which the element 13 moves are hatched.

A movement cycle starts when the element 13 is moved from its BDC position in the direction of the arrow F10.

The roll 22, contacting the pipe 2 by action of the spring 30, tends to rotate in the sense of the arrow F11 and then to move in the direction of the arrow F12, tightening the pipe 2 by friction.

Then, the pipe 2 tends to be dragged in motion by the hoisting element 13, in the sense of the arrow F10.

On the other hand, such a motion of the pipe causes the rotation of the roll belonging to the top hoisting element 11. This roll will rotate in the sense indicated by the arrow F13, thereby away from the pipe (arrow F14).

Such a situation persists until the movable element 13 reaches the TDC position (Figure 7B).

At this instant the element 13 reverts its motion and is moved in the direction indicated by the arrow 20 in Figure 7C.

Then, conditions specular to the abovedescribed ones take place.

In fact, the roll of the element 11 is led to rotate in the sense of the arrow F23, moving toward the pipe as indicated by the arrow F24 and tightening the same by friction against the wall of the top hoisting element 11.

Concomitantly, the roll of the element 13 tends to rotate in the sense of the arrow F21, moving away from the pipe 2 as indicated by the arrow F22 and thereby releasing the hold with respect to the pipe itself.

Thus, the pipe remains blocked in position by the (self-tightening) tightening mechanism of the element 11 and the element 13 can return, in the direction of the arrow 20, to its initial BDC position.

Then, a new hoisting cycle can start.

The next Figures 8A to 8D illustrate a mode of employ of the apparatus according to the present invention.

According to the foregoing, the piping is hoisted by a pair of hoisting elements 11, 13.

As it is known, said piping usually consist of different sections, connected thereamong by joints, ring nuts or the like, anyhow removable.

During the salvaging stage, there is the need of gradually disassembling the various sections extracted.

In order to easily and safely carry out such a step, the apparatus of the present invention provides a third top hoisting element 50.

The element 50 is structurally identical to the other ones, and it is mounted integrally to the frame 5, at a predetermined distance with respect to the moving assembly 10 and to the ground.

The piping 2, during the ascent, is threaded also through the through hole of said top element 50, entailing no hindrance whatsoever to the hoisting action.

The distance from ground of the top element 50 is such as to allow an operator to reach the joint 51 for the disassembling (Figure 8C).

Of course, a control (apparatus starting/stopping) system should be provided to allow each time the disassembling of the pipe sections.

Upon disassembling the joint, the pipe 2, according to the hereto-described operation of the hoisting element, remains overhung, blocked by the top element 50.

Then, by suitably tilting the pipe as indicated in Figure 8D, the operator could release the hold of the tightening mechanism and therefore unthread the pipe 2 bottomwise.

Alternatively, the top element 50 could be provided with a release 60, illustrated in the next Figures 9A, 9B and 9C.

In particular, the top element 50 comprises a system of levers 61, 62 that, actuated e.g. by traction of a string 63, drag a pair of racks 65, coupled to the gears.

By pulling the string 63 in the direction of the arrow F30 the racks 65 move in the direction of the arrow F31, dragging the roll that will rotate in the sense of the arrow F32, moving away from the pipe 2.

Thus, the operator could freely extract the pipe from the bottom.

Hereto it has been described, introducing several variants thereof, a first embodiment of the apparatus 1 according to the present invention, specifically contrived to operate according to a hoisting mode for the salvage of piping elements 2 and the like.

Hereinafter, with reference to Figures 11, 12, 13, 14, 15 and 16, it will be described a second embodiment of the apparatus 1 according to the present invention, envisaging design variants particularly suitable for carrying out the steps of in-depth ground laying of piping 2 and the like.

In this case as well, the operation principle of the apparatus 1 is based on the relative motion between the hoisting elements 11 and 13, suitably modified, and the piping 2 inserted therein.

As it is depicted in Figures 11 and 12, a first constructive variant of said second embodiment provides that a control bar 40 be slidably connected to the moving assembly 10.

Such a slidable connection may be attained, e.g., via the slidable coupling of suitable pins, integral to the frame 5, inside guides obtained on the body of the control bar 40.

Such a control bar 40 may thus be translated vertically and assume two extreme positions, corresponding to two different states, i.e. a first top position A and a second bottom position B.

The assumption of these two extreme positions takes place by means of the hoisting element 13 that, near the phases of its reciprocating motion corresponding to the bottom dead center BDC and top dead center TDC, pushes the control bar 40, via a mutual exchange of forces, from position A to position B, and, vice versa, from position B to position A, respectively.

Said control bar 40 is apt to cooperate with the hoisting elements 11 and 13, so as to define the synchronizations of the various stages of the laying cycle of the piping 2.

In fact, said control bar 40 is shaped so that, concomitantly to the assumption of the two abovementioned extreme positions A and B, relevant actuation mechanisms are triggered, finally causing the downward moving thereof.

The triggering is produced by the interaction of suitable intercepting elements obtained on the control bar 40 and on the moving assembly 10, with corresponding actuation mechanisms arranged on the hoisting elements 11 and 13.

Apart from the integration with said actuation mechanisms, the hoisting elements 11 and 13 are otherwise structurally analogous to those provided for the hoisting of the piping 2.

Said actuation mechanisms may be mechanical and electromechanical.

They comprise a system of levers 41 acting on a system of arms 43, rods 44 and racks 46, articulated and controlled so as to reciprocatingly move the rolls 22, mounted on the hoisting elements 11 and 13, near to or away from the piping 2.

In particular, as in the preceding case, in order to keep control of piping 2 and to avoid the loss thereof by slipping off, at each cycle stage, for the moving assembly 10 the tightening condition of the piping 10 by means of a first hoisting element should take place in advance with respect to the combined releasing of the hold onto the piping 2 by means of a second hoisting element.

Referring to Figures 13 and 14, the moving elements 11 and 13 are provided with a lever 41, projecting from the boxed body, lever that is moved when it contacts one of said intercepting elements.

Said intercepting elements may be tabs 42A, 42B and 42C integral to the control bar 40, or projections 42D integral to the frame 5.

The lever 41 is rigidly connected to an arm 43; at the respective ends of the latter, two respective rods 44 are hinged, e.g., with a pin joint.

Each rod 44 of said pair is hinged, at the opposite end thereof, to a respective rack 46.

Topwise, each of said racks is coupled to a respective gear 24 of the hoisting elements 11 and 13.

The configuration of the articulation deriving from the connection of the arm 43, the rods 44 and the racks 46 is determined by pins 45, located at the articulations of the rods 44 to the arm 43.

Said pins 45 are actuated by a suitable control system, e.g. by means of actuators 47 employing photoelectric detection position transducers.

Thus, the pins 45 are selectively extractable from respective recesses and, according to whether in the extracted position are found above or below said articulations, they constrain each respective articulation in a relevant configuration ensuring, respectively, the tightening of the rolls 22 onto the piping 2 or the releasing of the hold of the rolls 22 onto the piping 2 and, optionally, the mutual sliding.

From Figures 16A, 16B, 16C and 16D it is evident how, when the control system causes the extraction of the pins 45 above said articulation, the latter is then kept in a folded non-aligned configuration and the rolls 22 release the hold onto the piping 2; when instead the pins 45 are in an extracted position below the articulation, the latter is rigidly blocked in an extended configuration and the racks 46 mesh onto the gears 24 so that the rolls 22 remain pressed onto the piping 2, providing the tightening thereof by friction against the wall 21 of the relevant hoisting element.

The control system activates in connection with the position reached by the control bar 40 in its motion of vertical translation, with modes and times that will be made apparent in the following description of a downward movement cycle of the

piping 2.

Such a movement cycle starts when the element 13 is moved, in the direction of the arrow G10, from its position corresponding to the top dead center TDC.

The relative motion established between the element 13 and the piping 2 causes the rotation of the roll 22 of the element 13 according to the direction of the arrow G11, with the entailed hold onto the piping 2 and tightening by friction.

Then, the control bar 40 lies in the top position A, at which the combined action of the tab 42C onto the control bar 40 and of the pins 45, suitably positioned under said articulation, ensures the blocking in the assumed configuration and the keeping of the hold onto the piping 2, avoiding the slipping off and the entailed loss thereof.

Then, the pipe 2 tends to be dragged in motion by the element 13, in the sense of the arrow G10.

The lever 41 of the element remains undisturbed between the tabs 42A and 42B of the control bar 40, whereas the pins 45 onto the element 11 keep the relevant articulation in the folded configuration.

Such a situation persists until the element 13 gets near the bottom dead center BDC and impacts the tab 42E of the control bar 40.

By engaging to said tab 42E, the element 13 drags the control bar 40 until the latter is arranged in the bottom position B.

Concomitantly, the element 13 reaches its bottom dead center BDC.

In the bottom position B, the control system commands a reversion of the arrangement of the pins 45 which determine the configuration of the articulations on the moving elements 11 and 13, respectively.

As it is apparent in Figure 16B, the pipe is then held thanks to the tightening by means of the roll 22 of the element 11, which rotates in the direction of the arrow G30 by virtue of the relative motion between piping 2 and fixed element 11, blocking in the new position thanks to the joint action of the tab 42A and of the pins 45.

Concurrently, the projection 42D, by acting on the relevant articulation of the element 13, causes a rotation of the roll 22 of the element 13 in the direction of the arrow G40, with the entailed releasing of the hold of the roll 22 on the piping 2.

The resulting configuration is fixed thanks to the cooperation of the projection 4D with the pins 45, of which the control systems suitably arranges the extraction above said articulation.

Thus, while the piping 2 is held by the fixed hoisting element 11, the movable hoisting element 13 can ascend until rearranging at the top dead center TDC.

At said top dead center TDC, the overall configuration becomes the starting one again.

The lever 41 of the element 13 impacts the tab 42C, dragging upward the control bar 40 until the latter resumes the top position A.

Concomitantly, the folded articulation of the element 13 unfolds, upon rearrangement of the pins 45, and the roll of the element 13, by rotating in the direction of the arrow G11 under the action of the racks 46, tightens again the piping 2.

At the same time, the roll 22 of the fixed element 11 moves away, in the sense indicated by the arrow G12, so that a new laying cycle of the piping 2 can start with the descent of the element 13.

Advantageously, for the abovedescribed second embodiment of the apparatus 1 it is provided the introduction of deactivating means for the control bar 40, e.g., by moving away from the moving assembly 10, so that the use of the apparatus 1 for the salvage of piping may be converted at will, with a hoisting operation mode.

Upon detaching the control bar 40 of an useful distance, it is prevented the interaction of said intercepting elements, obtained on the control bar 40, with the actuation means on the elements 11 and 13.

Thus, the racks 46 meshing on the gears 24 merely support the rotations of the rolls 22 induced by the relative motion between piping 2 and elements 11 and 13.

For this purpose, the projections 42D integral to the frame 5 may be designed so as to be selectively retractable.

Moreover, the apparatus according to the present invention may advantageously comprise a safety device for automatically interrupting the operation thereof when the entire pipe has been salvaged and the pump connected thereto has surfaced.

Such a device could, e.g., act on a breaker to cut off power to the actuators and interrupt the operation of the apparatus.

Referring to Figures 11, 14 and 15, a further embodiment of the moving apparatus according to the present invention, applicable in both operation modes, for the hoisting or for the laying of piping 2, provides that the electric motor, rather than via a connecting rod system 16, actuate the hoisting element 13 thanks to the coupling to a worm screw-nut screw system.

The rotary motion transferred to a worm screw 71 by a motor 70, e.g. electric, is converted into linear motion of the hoisting element 13, incorporating the threaded seat of a nut screw 72.

As it is evident from the annexed Figures 17 and 18, a further embodiment of the moving apparatus 1 according to the present invention envisages the option of replacing the functionalities carried out by the control bar 40 for the synchronization of the control system, with detection devices 80, such as photoelectric cells, sending

signals to suitable actuators, e.g., electromagnetic, such as to coordinate each stage of the lowering cycle of the piping 2 in order to ensure the perfect repeatability thereof.

The roll element 22 having a substantially globe-shaped contour may be replaced by a different means for tightening the piping 2 to the wall portion 21 of the moving elements 11, 13.

Referring to Figures 19 and 20, such a function is carried out by a tie block 90 having a recess 91 reproducing in negative the contour of the piping 2.

The motion near to or away from with respect to the piping 2 is transmitted to the tie block 90 by the shaft 23, onto which the tie block 90 is pivoted, e.g. through the interposition of bearings.

The orientation of the block 90 with respect to the piping 2 is kept thanks to the introduction of a second shaft 92, jointed to the block 90 and constrained, like the shaft 23, to slide inside the pair of guide slots 26.

Thus, the tie block 90 is constrained to rigidly translate in the motion nearing to or away from with respect to the piping 2, so as to prevent a concomitant rotation thereof with respect to the hoisting element 11, 13, thereby ensuring at all times a perfect engagement of the recess 91 onto the piping 2.

The surface of said recess 91 is it also preferably made from material exhibiting a high friction coefficient or machined so as to have knurls or toothings apt to mesh on the external wall of the piping 2.

According to a further variant embodiment of the means for tightening the piping 2, illustrated in Figures 21 and 22, a tie block 93 cooperates with the roll 22 so that, with the carrying out of a joint tightening of the roll 22 and of the tie block 93 on said piping 2, it is concomitantly attained the result of an optimal adjustment of the hold of the roll 22 onto the piping 2.

In fact, the tie block 93 carries out a function of controlling the entity of the force exerted by the roll 22 when holding, substantially limiting the stroke thereof so as to prevent squeezing phenomena on the piping 2.

For this purpose, the tie block 93 and the roll 22 are connected with a connecting rod kinematic motion sized and configured so that the coming to hold of the tie block 93 substantially works as a stop to the advance of the roll 22.

Thanks to this technical solution, the tie block constrains the roll 22 so as to limit the compression exerted onto the piping 2 thereby.

Such a rod kinematic motion provides that a first end 98 of an element 94 substantially shaped as a connecting rod be hinged in an eccentric position onto the roll 22, preferably onto the peripheral portion of one of the side surfaces of the roll 22 at the top front quadrant thereof, and that a second end 99 of said element 94

substantially shaped as a connecting rod be hinged onto the tie block 93, e.g. onto one of the side surfaces thereof. The rotary motion of the roll 22, splined onto the shaft 23, is thus transformed into translatory motion of the tie block 93 nearing or moving away with respect to the piping 2.

Thus, the roll 22, by rotating, sets the tie block 93 in motion in a sense substantially agreeing with that of the shaft 23, so that a corresponding advancing or moving away of the tie block 93 with respect to the piping 2 is produced.

The tie block 93 is constrained, by means of a plurality of pins 96, to move rigidly on guide slots 97 obtained on the boxed body of the hoisting elements.

Said guide slots 97 have a tilt that is substantially defined by the positions assumed by the abovementioned second end 99 of the connecting rod 94, so that there be promoted a perfect sliding of the pins 96 therein, and no motion discontinuities be created.

The tie block 93 incorporates a recess 95 reproducing in negative the contour of said piping 2.

Compatibly with said configuration, and similarly to what has been observed for the preceding variant embodiment, the orientation of the block 93 with respect to the piping 2 is kept such as to anyhow ensure a perfect engagement of the recess 95 on the piping 2.

The joint hold of the tie block 93 and of the roll 22 onto the piping 2 provides a greater reliability to the apparatus.

The present invention was hereto disclosed according to a preferred embodiment thereof, given by way of a non-limiting example.

It is understood that other embodiments of the invention may be envisaged, all however falling within the protective scope thereof, as defined by the appended claims.